

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Original): A signal separation method that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

a procedure that transforms the observed signal values observed by said sensors into frequency-domain signal values,

a procedure that uses said frequency-domain signal values to calculate at each frequency the relative values of the observed values between said sensors (including mapping these relative values),

a procedure that clusters said relative values into  $N$  clusters,

a procedure that calculates a representative value for each of said clusters,

a procedure that uses said representative values to generate a mask for the purpose of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from  $V$  ( $2 \leq V \leq M$ ) signal sources,

a procedure that uses said mask to extract said mixed signal values from said frequency-domain signal values, and

a procedure that separates and extracts the values of  $V$  signals from said mixed signal values.

Claim 2 (Previously Presented): A signal separation method according to Claim 1, wherein said mask is a function that takes a high level value for said relative values that are within a prescribed range that includes  $V$  said representative values, and takes a low level value for said representative values that are not inside said prescribed range,

and wherein the procedure that uses said mask to extract said mixed signal values from said frequency-domain signal values is a procedure in which said frequency-domain signal values are multiplied by said mask.

Claim 3 (Original): A signal separation method according to Claim 1, wherein said mask is a function that takes a low level value for said relative values that are within a prescribed range that includes V said representative values, and takes a high level value for said representative values that are not inside said prescribed range,

and wherein the procedure that uses said mask to extract said mixed signal values from said frequency-domain signal values is a procedure in which the values obtained by multiplying said frequency-domain signal values by said mask are subtracted from said frequency-domain signal values.

Claim 4 (Original): A signal separation method according to Claim 2, wherein said mask is a function that the transitions from said high level value to said low level value that accompany changes of said relative value occur in a continuous fashion.

Claim 5 (Original): A signal separation method according to Claim 1, wherein the procedure that uses said representative values to generate a mask for the purpose of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from V ( $2 \leq V \leq M$ ) signal sources is a procedure whereby said mask is generated by using the directional characteristics of a null beamformer (NBF).

Claim 6 (Currently Amended): A signal separation method according to Claim 1, wherein the procedure that uses said representative values to generate a mask for the purpose

of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from  $V$  ( $2 \leq V \leq M$ ) signal sources includes:

a procedure that generates an  $(N-V+1) \times (N-V+1)$  delay matrix  $H_{\text{NBF}}(f)$  in which the element at  $(j,i)$  is equal to  $\exp(j2\pi f \tau_{ji})$ , where  $\tau_{ji} = (d_j/v_e) \cos \theta_i$ ,  $v_e$  is the velocity of the signals,  $d_j$  is the distance between sensor 1 and sensor  $j$  ( $j=1, \dots, N-V+1$ ),  $\theta_1$  is any one of the estimated directions of the signal sources corresponding to the  $V$  said representative values,  $\theta_i$  ( $i=2, \dots, N-V+1$ ) are the estimated directions of the signal sources corresponding to the other said representative values of the  $V$  said representative values, and  $f$  is a frequency variable,

a procedure that calculates the inverse matrix  $W(f) = H_{\text{NBF}}^{-1}(f)$  of delay matrix  $H_{\text{NBF}}(f)$  as a NBF matrix  $W(f)$ ,

a procedure that generates a directional characteristics function

FORMULA 54

$$F(f, \theta) = \frac{\sum_{k=1}^{N-V+1} W_{1k}(f) \exp(j2\pi f d_k \cos \theta / v_e)}{\sum_{k=1}^{N-V+1} W_{1k}(f) \exp(j2\pi f d_k \cos \theta / v_e)}$$

where  $\theta$  is a signal arrival direction variable, and the first row element of said NBF matrix  $W(f)$  is  $W_{1k}(f)$ ,

and a procedure that uses said directional characteristics function  $F(f, \theta)$  to generate said mask.

Claim 7 (Original): A signal separation method according to Claim 1, wherein the procedure that uses said representative values to generate a mask for the purpose of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from  $V$  ( $2 \leq V \leq M$ ) signal sources includes:

a procedure that generates a function consisting of a single-peak function convolved with a binary mask, which is a function that takes a high level value for said relative values that are within a prescribed range including  $V$  said representative values and takes a low level value for said representative values that are not inside said prescribed range and where changes of the relative value are accompanied by discontinuous transitions from said high level value to said low level value,

and a procedure that generates said mask as a function in which said relative values are substituted into said function consisting of a single-peak function convolved with a binary mask.

Claim 8 (Original): A signal separation method according to Claim 1, wherein the procedure that uses said representative values to generate a mask for the purpose of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from  $V$  ( $2 \leq V \leq M$ ) signal sources is

a procedure that generates said mask as a single-peak function obtained by mapping the differences between a first odd function that takes a value of zero when said relative value is the lower limit value  $a_{\min}$  in a prescribed range including  $V$  said representative values and a second odd function that takes a value of zero when said representative value is the upper limit value  $a_{\max}$  in said prescribed range.

Claim 9 (Previously Presented): A signal separation method according to one of Claims 2 or 3, wherein

said mask is a function that transitions from said high level value to said low level value occur in a discontinuous fashion.

Claim 10 (Original): A signal separation method that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

- a procedure that transforms the observed signal values observed by said sensors into frequency-domain signal values,

- a procedure that uses said frequency-domain signal values to calculate at each frequency the relative values of the observed values between said sensors (including mapping these relative values),

- a procedure that clusters said relative values into  $N$  clusters,

- a procedure that calculates a representative value for each of said clusters,

- a procedure that generates a mask function that takes a high level value for said relative values that are within a prescribed range that includes one of the said representative values, and takes a low level value for said representative values that are not inside said prescribed range, wherein the transitions from said high level value to said low level value that accompany changes of said relative value occur in a continuous fashion,

- and a procedure that multiplies said frequency-domain signal values by said mask to extract the signal emitted from one signal source.

Claim 11 (Original): A signal separation method that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

- a procedure that transforms the observed signal values  $x_1(t), \dots, x_M(t)$  observed by said sensors into frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$ ,

a procedure that clusters first vectors  $X(f,m)=[X_1(f,m),...,X_M(f,m)]$  comprising said frequency-domain signal values  $X_1(f,m),...,X_M(f,m)$  into  $N$  clusters  $C_i(f)$  ( $i=1,...,N$ ) at each frequency  $f$ ,

a procedure that calculates second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ ,

a procedure that extracts  $V$  ( $1 \leq V \leq M$ ) third vectors  $a_p(f)$  ( $p=1,...,V$ ) from said second vectors  $a_i(f)$ ,

a procedure that generates a mask  $M(f,m)$  represented by the formula

Formula 55

$$M(f,m) = \begin{cases} 1 & \max_{a_p(f) \in G_k} D(X(f,m), a_p(f)) < \min_{a_q(f) \in G_k^c} D(X(f,m), a_q(f)) \\ 0 & \text{otherwise} \end{cases}$$

where  $G_k$  is the set of said third vectors  $a_p(f)$ ,  $G_k^c$  is the complementary set of  $G_k$ , and  $D(\alpha, \beta)$  is the Mahalanobis square distance between the vectors  $\alpha$  and  $\beta$ ,

and a procedure that extracts the signal values emitted from  $V$  of said signal sources by calculating the product of said mask  $M(f,m)$  and said first vectors  $X(f,m)$ .

Claim 12 (Original): A signal separation method that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, wherein

a procedure that transforms the observed signal values  $x_1(t),...,x_M(t)$  observed by said sensors into frequency-domain signal values  $X_1(f,m),...,X_M(f,m)$ ,

a procedure that clusters first vectors  $X(f,m)=[X_1(f,m),...,X_M(f,m)]$  comprising said frequency-domain signal values  $X_1(f,m),...,X_M(f,m)$  into  $N$  clusters  $C_i(f)$  ( $i=1,...,N$ ) at each frequency  $f$ ,

a procedure that calculates second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ ,

a procedure that extracts  $V$  ( $1 \leq V \leq M$ ) third vectors  $a_p(f)$  ( $p=1, \dots, V$ ) from said second vectors  $a_i(f)$ ,

and a procedure that judges whether or not said first vectors  $X(f, m)$  satisfy the relationship

Formula 56

$$\max_{a_p(f) \in G_k} D(X(f, m), a_p(f)) < \min_{a_q(f) \in G_k^c} D(X(f, m), a_q(f))$$

where  $G_k$  is the set of said third vectors  $a_p(f)$ ,  $G_k^c$  is the complementary set of  $G_k$ , and  $D(\alpha, \beta)$  is the Mahalanobis square distance between the vectors  $\alpha$  and  $\beta$ , and, if so, extracts said first vectors  $X(f, m)$  as the signal values emitted from  $V$  of the said signal sources.

Claim 13 (Previously Presented): A signal separation method according to one of Claims 11 or 12, wherein said clustering procedure is performed after performing the calculation

Formula 57

$$\text{sign}(X_j(f, m)) \leftarrow \begin{cases} X_j(f, m) / |X_j(f, m)| & (|X_j(f, m)| \neq 0) \\ 0 & (|X_j(f, m)| = 0) \end{cases}$$

and

$$X(f, m) \leftarrow \begin{cases} X(f, m) / \text{sign}(X_j(f, m)) & (|X_j(f, m)| \neq 0) \\ X(f, m) & (|X_j(f, m)| = 0) \end{cases}$$

Claim 14 (Original): A signal separation method according to Claim 13, wherein said clustering procedure is performed after performing the calculation

Formula 58

$$X(f, m) \leftarrow \begin{cases} X(f, m) / \|X(f, m)\| & (\|X(f, m)\| \neq 0) \\ X(f, m) & (\|X(f, m)\| = 0) \end{cases}$$

(where the notation  $\|X(f, m)\|$  denotes the norm of  $X(f, m)$ ).

After said formula

$$X(f, m) \leftarrow \begin{cases} X(f, m) / \text{sign}(X_j(f, m)) & (|X_j(f, m)| \neq 0) \\ X(f, m) & (|X_j(f, m)| = 0) \end{cases}$$

Claim 15 (Original): A signal separation method that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising

a procedure that transforms the observed signal values  $x_1(t), \dots, x_M(t)$  observed by said sensors into frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$ ,

a procedure that clusters first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]^T$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each frequency  $f$ ,

a procedure that calculates second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ ,

a procedure that calculates an  $N$ -row  $\times$   $M$ -column separation matrix  $W(f, m)$  that is the Moore-Penrose pseudo-inverse matrix of an  $M$ -row  $\times$   $N$ -column matrix in which 0 or more of the  $N$  said second vectors  $a_i(f)$  are substituted with zero vectors,

and a procedure that calculates a separated signal vector

$Y(f, m) = [Y_1(f, m), \dots, Y_N(f, m)]^T$  by performing the calculation  $Y(f, m) = W(f, m)X(f, m)$ .

Claim 16 (Original): A signal separation method according to Claim 15, wherein:

the procedure that calculates said separation matrix  $W(f, m)$  is a procedure that selects  $\min(M, N)$  said second vectors  $a_i(f)$ , generates a matrix  $A'(f, m)$  whose columns are the selected  $\min(M, N)$  said second vectors  $a_i(f)$  and  $\max(N - M, 0)$  zero vectors, and calculates



said separation matrix  $W(f,m)$  as the Moore-Penrose pseudo-inverse matrix of said matrix  $A'(f,m)$ .

Claim 17 (Original): A signal separation method according to Claim 15, wherein:  
the procedure used to calculate said separation matrix  $W(f,m)$  when  $N > M$  is a procedure that selects  $M$  said second vectors  $a_i(f)$  in each discrete time interval  $m$ , generates a matrix  $A'(f,m)$  whose columns are the selected  $M$  said second vectors  $a_i(f)$  and  $N-M$  zero vectors, and calculates said (time-dependent) separation matrix  $W(f,m)$  as the Moore-Penrose pseudo-inverse matrix of said matrix  $A'(f,m)$ ,

and the procedure used to calculate said separation matrix  $W(f,m)$  when  $N \leq M$  is a procedure that calculates the Moore-Penrose pseudo-inverse matrix of a matrix comprising  $N$  said second vectors in each said cluster  $C_i(f)$  to yield said (time-invariant) separation matrix  $W(f,m)$ .

Claim 18 (Original): A signal separation method according to Claim 15, wherein:  
said clustering procedure is performed after performing the calculation

Formula 59

$$\text{sign}(X_j(f,m)) \leftarrow \begin{cases} X_j(f,m)/|X_j(f,m)| & (|X_j(f,m)| \neq 0) \\ 0 & (|X_j(f,m)| = 0) \end{cases}$$

and

$$X(f,m) \leftarrow \begin{cases} X(f,m)/\text{sign}(X_j(f,m)) & (|X_j(f,m)| \neq 0) \\ X(f,m) & (|X_j(f,m)| = 0) \end{cases}$$

Claim 19 (Original): A signal separation method according to Claim 18, wherein:  
said clustering procedure is performed after performing the calculation

Formula 60

$$X(f, m) \leftarrow \begin{cases} X(f, m) / \| X(f, m) \| & (\| X(f, m) \| \neq 0) \\ X(f, m) & (\| X(f, m) \| = 0) \end{cases}$$

(where the notation  $\| X(f, m) \|$  denotes the norm of  $X(f, m)$ ).

in addition to said formula

$$X(f, m) \leftarrow \begin{cases} X(f, m) / \text{sign}(X_j(f, m)) & (| X_j(f, m) | \neq 0) \\ X(f, m) & (| X_j(f, m) | = 0) \end{cases}$$

Claim 20 (Previously Presented): A signal separation method according to Claim 16, wherein

said procedure that selects  $\min(M, N)$  said second vectors  $a_i(f)$  comprises [[is]]  
 a procedure that initializes fourth vectors  $e$  with said first vectors  $X(f, m)$ , and  
 a procedure that repeats a process  $\min(M, N)$  times, wherein  
 said process comprises steps for selecting said second vectors  $a_{q(u)}(f)$  that maximize the absolute value of the dot product of  $a_{q(u)}(f) / \| a_{q(u)}(f) \|$  and said fourth vectors, setting up a matrix  $Q = [a_{q(1)}(f), \dots, a_{q(k)}(f)]$  representing the subspace subtended by all said second vectors  $a_{q(u)}(u=1, \dots, k)$  selected so far, performing the calculation  $P = Q(Q^H Q)^{-1} Q^H$ , and updating the fourth vectors  $e$  with  $e = X(f, m) - P \cdot X(f, m)$ .

Claim 21 (Previously Presented): A signal separation device that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

a memory unit that stores the observed signal values observed by said sensors;  
 and a processor which is connected to said memory unit and is configured to transform said observed signal values into frequency-domain signal values, to use said

frequency-domain signal values to calculate at each frequency the relative values of the observed values between said sensors (including mapping these relative values), to cluster said relative values into  $N$  clusters, to calculate a representative value for each of said clusters, to use said representative values to generate a mask for the purpose of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from  $V$  ( $2 \leq V \leq M$ ) signal sources, to use said mask to extract said mixed signal values from said frequency-domain signal values, and to separate and extract the values of  $V$  signals from said mixed signal values.

Claim 22 (Previously Presented): A signal separation device that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

a memory unit that stores the observed signal values observed by said sensors;

and a processor which is connected to said memory unit and is configured to transform said observed signal values into frequency-domain signal values, to use said frequency-domain signal values to calculate at each frequency the relative values of the observed values between said sensors (including mapping these relative values), to cluster said relative values into  $N$  clusters, to calculate a representative value for each of said clusters, to generate a mask, which is a function that takes a high level value for said relative values that are within a prescribed range that includes one said representative value, and takes a low level value for said representative values that are not inside said prescribed range, and where the transitions from said high level value to said low level value that accompany changes of said relative value occur in a continuous fashion, and to extract the values of a signal emitted from one signal source by multiplying said frequency-domain values by said mask.

Claim 23 (Previously Presented): A signal separation device that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

a memory unit that stores the observed signal values  $x_1(t), \dots, x_M(t)$  observed by said sensors;

and a processor which is connected to said memory unit and is configured to transform said observed signal values  $x_1(t), \dots, x_M(t)$  into frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$ , to cluster first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each frequency  $f$ , to calculate second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ , and extracts  $V$  ( $1 \leq V \leq M$ ) third vectors  $a_p(f)$  ( $p=1, \dots, V$ ) from said second vectors  $a_i(f)$ , to generate a mask  $M(f, m)$  represented by the formula

Formula 61

$$M(f, m) = \begin{cases} 1 & \max_{a_p(f) \in G_k} D(X(f, m), a_p(f)) < \min_{a_q(f) \in G_k^c} D(X(f, m), a_q(f)) \\ 0 & \text{otherwise} \end{cases}$$

where  $G_k$  is the set of said third vectors  $a_p(f)$ ,  $G_k^c$  is the complementary set of  $G_k$ , and  $D(\alpha, \beta)$  is the Mahanalobis square distance between the vectors  $\alpha$  and  $\beta$ , and to extract the signal values emitted from  $V$  of the said signal sources by calculating the product of said mask  $M(f, m)$  and said first vectors  $X(f, m)$ .

Claim 24 (Previously Presented): A signal separation device that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

a memory unit that stores the observed signal values  $x_1(t), \dots, x_M(t)$  observed by said sensors;

and a processor which is connected to said memory unit and is configured to transform said observed signal values  $x_1(t), \dots, x_M(t)$  into frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$ , to cluster first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each frequency  $f$ , to calculate second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ , to extract  $V$  ( $1 \leq V \leq M$ ) third vectors  $a_p(f)$  ( $p=1, \dots, V$ ) from said second vectors  $a_i(f)$ , to judge whether or not said first vectors satisfy the relationship

Formula 62

$$\max_{a_p(f) \in G_k} D(X(f, m), a_p(f)) < \min_{a_q(f) \in G_k^c} D(X(f, m), a_q(f))$$

where  $G_k$  is the set of said third vectors  $a_p(f)$ ,  $G_k^c$  is the complementary set of  $G_k$ , and  $D(\alpha, \beta)$  is the Mahalanobis square distance between the vectors  $\alpha$  and  $\beta$ , and  $[[,]]$  to extract said first vectors  $X(f, m)$  satisfying said relationship as the signal values emitted from  $V$  of the said signal sources.

Claim 25 (Previously Presented): A signal separation device that separates and extracts signals under conditions where  $N$  ( $N \geq 2$ ) signals are mixed together and observed with  $M$  sensors, comprising:

a memory unit that stores the observed signal values  $x_1(t), \dots, x_M(t)$  observed by said sensors;

and a processor which is connected to said memory unit and is configured to transform said observed signal values  $x_1(t), \dots, x_M(t)$  into frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$ , to cluster first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]^T$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each

frequency  $f$ , to calculate second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ , to calculate an  $N$ -row  $\times$   $M$ -column separation matrix  $W(f,m)$  that is the Moore-Penrose pseudo-inverse matrix of an  $M$ -row  $\times$   $N$ -column matrix in which 0 or more of the  $N$  said second vectors  $a_i(f)$  are substituted with zero vectors, and to calculate a separated signal vector  $Y(f,m)=[Y_1(f,m),\dots,Y_N(f,m)]^T$  by performing the calculation  $Y(f,m)=W(f,m)X(f,m)$ .

Claim 26 (Previously Presented): A computer readable medium storing a signal separation program, which when executed by a computer causes the computer to perform:

a procedure that transforms observed signal values, which are mixtures of  $N$  ( $N \geq 2$ ) signals observed with  $M$  sensors, into frequency-domain values,  
a procedure that uses said frequency-domain signal values to calculate at each frequency the relative values of the observed values between said sensors (including mapping these relative values),

a procedure that clusters said relative values into  $N$  clusters,

a procedure that calculates a representative value for each of said clusters,

a procedure that uses said representative values to generate a mask for the purpose of extracting, from said frequency-domain signal values, mixed signal values comprising the signals emitted from  $V$  ( $2 \leq V \leq M$ ) signal sources,

a procedure that uses said mask to extract said mixed signal values from said frequency-domain signal values, and

a procedure that separates and extracts the values of  $V$  signals from said mixed signal values.

Claim 27 (Original): A computer readable medium storing a signal separation program, which when executed by a computer, causes the computer to perform:

a procedure that transforms observed signal values, which are mixtures of  $N$  ( $N \geq 2$ ) signals observed with  $M$  sensors, into frequency-domain values,

a procedure that uses said frequency-domain signal values to calculate at each frequency the relative values of the observed values between said sensors (including mapping these relative values),

a procedure that clusters said relative values into  $N$  clusters,

a procedure that calculates a representative value for each of said clusters,

a procedure that generates a mask, which is a function that takes a high level value for said relative values that are within a prescribed range that includes one of said representative values, and takes a low level value for said representative values that are not inside said prescribed range, wherein the transitions from said high level value to said low level value that accompany changes of said relative value occur in a continuous fashion,

and a procedure that extracts the signal values emitted from one signal source by multiplying said frequency-domain signal values by said mask.

Claim 28 (Previously Presented): A computer readable medium storing a signal separation program, which when executed by a computer, causes the computer to perform:

a procedure that transforms observed signal values  $x_1(t), \dots, x_M(t)$ , which are mixtures of  $N$  ( $N \geq 2$ ) signals observed by  $M$  sensors, into frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$ ,

a procedure that clusters first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each frequency  $f$ ,

a procedure that calculates second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ ,

a procedure that extracts  $V$  ( $1 \leq V \leq M$ ) third vectors  $a_p(f)$  ( $p=1, \dots, V$ ) from said second vectors  $a_i(f)$ ,

a procedure that generates a mask  $M(f, m)$  represented by the formula

Formula 63

$$M(f, m) = \begin{cases} 1 & \max_{a_p(f) \in G_k} D(X(f, m), a_p(f)) < \min_{a_q(f) \in G_k^c} D(X(f, m), a_q(f)) \\ 0 & \text{otherwise} \end{cases}$$

where  $G_k$  is the set of said third vectors  $a_p(f)$ ,  $G_k^c$  is the complementary set of  $G_k$ , and  $D(\alpha, \beta)$  is the Mahalanobis square distance between the vectors  $\alpha$  and  $\beta$ ,

and a procedure that extracts the signal values emitted from  $V$  of said signal sources by calculating the product of said mask  $M(f, m)$  and said first vectors  $X(f, m)$ .

Claim 29 (Previously Presented): A computer readable medium storing signal separation program, which when executed by a computer, causes the computer to perform:

a procedure that transforms observed signal values  $x_1(t), \dots, x_M(t)$ , which are mixtures of  $N$  ( $N \geq 2$ ) signals observed by  $M$  sensors, into frequency-domain signal values

$X_1(f, m), \dots, X_M(f, m)$ ,

a procedure that clusters first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each frequency  $f$ ,

a procedure that calculates second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ ,

a procedure that extracts  $V$  ( $1 \leq V \leq M$ ) third vectors  $a_p(f)$  ( $p=1, \dots, V$ ) from said second vectors  $a_i(f)$ ,

and a procedure that judges whether or not said first vectors  $X(f, m)$  satisfy the relationship

Formula 64



$$\max_{a_p(f) \in G_k} D(X(f, m), a_p(f)) < \min_{a_q(f) \in G_k^c} D(X(f, m), a_q(f))$$

where  $G_k$  is the set of said third vectors  $a_p(f)$ ,  $G_k^c$  is the complementary set of  $G_k$ , and  $D(\alpha, \beta)$  is the Mahalanobis square distance between the vectors  $\alpha$  and  $\beta$ , and, if so, extracts said first vectors  $X(f, m)$  as the signal values emitted from  $V$  of the said signal sources.

Claim 30 (Previously Presented): A computer readable medium storing a signal separation program, which when executed by a computer, causes the computer to perform:

a procedure that transforms observed signal values  $x_1(t), \dots, x_M(t)$ , which are mixtures of  $N$  ( $N \geq 2$ ) signals observed by  $M$  sensors, into frequency-domain signal values

$X_1(f, m), \dots, X_M(f, m)$ ,

a procedure that clusters first vectors  $X(f, m) = [X_1(f, m), \dots, X_M(f, m)]^T$  comprising said frequency-domain signal values  $X_1(f, m), \dots, X_M(f, m)$  into  $N$  clusters  $C_i(f)$  ( $i=1, \dots, N$ ) at each frequency  $f$ ,

a procedure that calculates second vectors  $a_i(f)$  to represent each said cluster  $C_i(f)$ ,

a procedure that calculates an  $N$ -row  $\times$   $M$ -column separation matrix  $W(f, m)$  that is the Moore-Penrose pseudo-inverse matrix of an  $M$ -row  $\times$   $N$ -column matrix in which 0 or more of the  $N$  said second vectors  $a_i(f)$  are substituted with zero vectors,

and a procedure that calculates a separated signal vector

$Y(f, m) = [Y_1(f, m), \dots, Y_N(f, m)]^T$  by performing the calculation  $Y(f, m) = W(f, m)X(f, m)$ .

Claim 31 (Canceled).